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/Chih-Sheng Lin/
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Patent
Attorney Docket: H37-091 DIV
Firm: Notaro & Michalos P.C.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : J. Schmitt
Application No. : 09/824,936
Filing Date : April 3, 2001
For : PLASMA REACTOR FOR THE TREATMENT
OF LARGE SIZE SUBSTRATES
Examiner : Anna M. Crowell
Art Unit : 1763

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REPLY BRIEF UNDER 37 C.F.R. § 41.41

This Reply Brief is being submitted in response to the Examiner's Answer dated January 11, 2007 in connection with the above-identified application.

I. SUMMARY

This paper is submitted as part of an appeal from the rejections set forth in the final Office Action dated May 11, 2006, in the above-referenced application. The first issue on appeal is whether claims 1, 3, 4 and 6-8 are patentable over the combined teachings of Japanese Patent Publication 08-186094 of Hanada (hereinafter referred to as "Hanada"), U.S. Patent No. 6,177,023 to Shang, et al. (hereinafter referred to as "Shang") and U.S. Patent No. 5,210,466 to Collins, et al. (hereinafter referred to as "Collins"). The second issue on appeal is whether claims 1, 3, 4 and 6-8 are patentable over the combined teachings of Hanada, Shang and U.S. Patent No. US 6,199,505 to Sato, et al. (hereinafter referred to as "Sato").

II. STATUS OF THE CLAIMS

Claims 1, 3, 4 and 6-8, which were finally rejected by the Examiner as noted in the final Office Action dated May 11, 2006, are being appealed.

Claims 2 and 9-12 have been withdrawn.

Claims 5 and 13-15 have been canceled without prejudice.

III. ISSUES IN REPLY BRIEF

In the Examiner's Answer dated January 11, 2007, the Examiner maintains that it would have been obvious to one of ordinary skill in the art at the time of the invention for the radio frequency generator of Hanada to apply frequencies greater than 13.56 MHz, and to provide the apparatus of Hanada with a substrate having a largest dimension of up to

1m based on the teachings of the references applied by the Examiner. Applicant respectfully disagrees with the arguments asserted by the Examiner for at least the following reasons.

As stated at MPEP § 2142, “[t]o establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations” (citation omitted). The Examiner’s Answer fails to establish at least one of the criteria set forth above.

A. Applicant’s Invention

Applicant’s invention relates to an improved capacitively coupled radio frequency (RF) plasma reactor (also known as parallel plate RF plasma reactor) for processing large size substrates (e.g., with a largest dimension of at least 0.7m) at RF frequency greater than 13.56 MHz. See Applicant’s independent claim 1.

Capacitive RF plasma reactors are typically used for exposing a substrate to the processing action of a glow discharge. Various processes are used to modify the nature of the substrate surface. Depending on the process and in particular the nature of the gas injected into the glow discharge, the substrate properties can be modified such as through adding or selectively removing a thin film from the surface of the substrate. See Applicant’s specification at page 1, lines 11-16.

An important observation was noted especially if the RF frequency is higher than

13.56 MHz and a large size substrate is used, such that the reactor size is no longer negligible relative to the free space wave length of the RF electromagnetic wave. As a result, the plasma intensity along the reactor is no longer uniform. Physically, the origin of such a limitation may lie in the fact that the RF wave is distributed according to the beginning of a “standing wave” spacial oscillation within the reactor. See Applicant’s specification, page 2, lines 12-18.

The present invention thus provides an improved capacitively coupled RF plasma reactor for eliminating or notably reducing the electromagnetic non-uniformity in a reactor designed to process large size substrates ($\geq 0.7\text{m}$) at RF frequency higher than 13.56 MHz.

B. First Rejection Under 35 U.S.C. § 103

Claims 1, 3, 4 and 6-8 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the combined teachings of Hanada, Shang and Collins.

The Examiner alleges that Hanada discloses a capacitively coupled radio frequency plasma reactor as recited in claim 1. See Examiner’s Answer at page 4, last paragraph. The Examiner admits that Hanada fails to teach a radio frequency generator for frequencies greater than 13.56 MHz and at least one substrate with a largest dimension of at least 0.7m. See Examiner’s Answer at page 5, first paragraph.

To meet these deficiencies, the Examiner alleges that Collins discloses a capacitively coupled radio frequency plasma reactor using a radio frequency generator which applies frequencies greater than 13.56 MHz. See Examiner’s Answer at page 5, second paragraph. The Examiner then concludes that one of ordinary skill in the art would

be motivated to combine the teachings of Hanada with Collins because higher frequencies provide commercially viable processing rates and substantial reduction in sheath voltage. See Examiner's Answer at page 5, second paragraph.

The Examiner further alleges that Shang teaches a plasma reactor for processing a substrate for flat panel displays with a largest dimension of up to 1 m. Examiner's Answer at page 5, third paragraph. The Examiner then concludes that one of ordinary skill in the art would be motivated to provide the apparatus of Hanada with a substrate having a largest dimension of up to 1 m because it is well known in the art to scale up or down an apparatus to accommodate the desired substrate size. See Examiner's Answer at page 5, third paragraph.

The state of the art at the time of the filing of the present application is such that merely utilizing a higher frequency generator (>13.56 MHz) in a plasma reactor as taught by Collins and scaling up the reactor chamber to accommodate a substrate of up to 1 square meter as taught by Shang would result in non-uniform plasma intensity along the reactor. See Applicant's specification at page 2, lines 12-19. Without any teachings or suggestions for compensating for the expected non-uniformities in the plasma density as a result of the modifications proposed by the Examiner, one of ordinary skill in the art would readily appreciate the problems that will be encountered when a reactor, including the one described in Hanada, is scaled up to process large-size substrates (≥ 0.7 m) at high frequencies (>13.56 MHz). Hanada, as the Examiner has admitted, does not teach a reactor that can process large-size substrates (≥ 0.7 m), and thus, given the level of knowledge and skill in the art at the time of the invention, does not provide any suggestion that it will not face the same problems as any other reactor which has been simply scaled

up to accommodate a substrate with a largest dimension of at least 0.7m. Therefore, an ordinarily skilled artisan would not be motivated to combine Hanada, Collins and Shang because plasma non-uniformity is expected to occur. Moreover, Hanada, Collins and Shang do not provide any reasonable expectation that the proposed modification advanced by the Examiner would be successful absent any guidance for dealing with the causes of plasma non-uniformity (such as “standing wave” effect) in large-size, high frequency plasma reactors. Accordingly, Applicant respectfully maintains that the Examiner’s Answer, like the Office Actions, fails to satisfy the burden of establishing prima facie obviousness.

Thus, Applicant respectfully submits that claim 1 should be allowable over Hanada, Collins and Shang. Claims 3, 4 and 6-8 depend on claim 1 and should also be allowable at least by virtue of their dependencies.

C. Second Rejection Under 35 U.S.C. § 103

Claims 1, 3, 4 and 6-8 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the combined teachings of Hanada, Shang and Sato.

The Examiner alleges that Hanada discloses a capacitively coupled radio frequency plasma reactor as recited in claim 1. See Examiner’s Answer at page 7, fourth paragraph. The Examiner admits that Hanada fails to teach a radio frequency generator for frequencies greater than 13.56 MHz and at least one substrate with a largest dimension of at least 0.7m. See Examiner’s Answer at page 8, first paragraph.

To meet these deficiencies, the Examiner alleges that Sato discloses a capacitively coupled radio frequency plasma reactor designed to use a radio frequency generator which applies frequencies greater than 13.56 MHz and that processes a substrate with a largest

dimension of at least 0.7m. See Examiner's Answer at page 8, second paragraph. The Examiner then concludes that one of ordinary skill in the art would be motivated to design the reactor of Hanada to apply frequencies greater than 13.56 MHz and accommodate at least one substrate with a largest dimension of at least 0.7m because there is a growing demand to process large substrates. See Examiner's Answer at page 8, second paragraph.

The Examiner further alleges that Shang teaches a plasma reactor for processing a substrate for flat panel displays with a largest dimension of up to 1 m. Examiner's Answer at page 8, third paragraph. The Examiner then concludes that one of ordinary skill in the art would be motivated to provide the apparatus of Hanada with a substrate having a largest dimension of up to 1 m with appropriate power level because it is well known in the art to scale up or down an apparatus to accommodate the desired substrate size. See Examiner's Answer at top of page 9.

The state of the art at the time of the filing of the present application is such that merely utilizing a higher frequency generator (>13.56 MHz) in a plasma reactor as taught by Sato and scaling up the reactor chamber to accommodate a substrate of up to 1 square meter as taught by Sato and Shang would result in non-uniform plasma intensity along the reactor. See Applicant's specification at page 2, lines 12-19. Without any teachings or suggestions for compensating for the expected non-uniformities in the plasma density as a result of the modifications proposed by the Examiner, one of ordinary skill in the art would readily appreciate the problems that will be encountered when a reactor, including the one described in Hanada, is scaled up to process large-size substrates (≥ 0.7 m) at high frequencies (>13.56 MHz). Hanada, as the Examiner has admitted, does not teach a

reactor that can process large-size substrates ($\geq 0.7\text{m}$), and thus, given the level of knowledge and skill in the art at the time of the invention, does not provide any suggestion that it will not face the same problems as any other reactor which has been simply scaled up to accommodate a substrate with a largest dimension of at least 0.7m. Therefore, an ordinarily skilled artisan would not be motivated to combine Hanada, Sato and Shang because plasma non-uniformity is expected to occur. Moreover, Hanada, Sato and Shang do not provide any reasonable expectation that the proposed modification advanced by the Examiner would be successful absent any guidance for dealing with the causes of plasma non-uniformity (such as “standing wave” effect) in large, high frequency plasma reactors. Accordingly, Applicant respectfully maintains that the Examiner’s Answer, like the Office Actions, fails to satisfy the burden of establishing prima facie obviousness.

Thus, Applicant respectfully submits that claim 1 should be allowable over Hanada, Sato and Shang. Claims 3, 4 and 6-8 depend on claim 1 and should also be allowable at least by virtue of their dependencies.

IV. CONCLUSION

Based on the foregoing reasons, Applicant respectfully maintains that the cited references do not disclose, teach, or suggest each and every feature recited in claims 1, 3, 4 and 6-8. It is further submitted that the differences between the invention claimed in claims 1, 3, 4 and 6-8 and the cited references would not have been obvious to a person having ordinary skill in the art at the time the invention was made.

Respectfully submitted,

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